Drying of Barrier Coatings

Blistering Free and Fast Drying of Barrier Coatings

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Coat drying is a critical part of paper making. Particular difficulties arise when drying barrier coatings, as the drying process also creates the barrier effect. If there is still water below the formed film on the surface of the functional coating, it will later - but usually earlier - damage the surface as soon as it evaporates. Therefore, the correct drying curve is an essential part of drying barrier coatings. In most cases, the production speed has to be reduced considerably in comparison to normal coatings, as barrier coatings often have a very high wet coat weight. In special cases, the production speed is only a third or even a quarter of the normal speed.

If, on the other hand, the barrier coating is dried optimally starting from the initial sediment layer, there is no premature film formation on the surface and all the water can be evaporated without subsequently damaging the barrier.

We show the physical principles of drying and their influence on the drying of barriers, but also on coatings in general; and we show how the operating window can be considerably widened, especially in terms of production speed.

1. Introduction

Very long hot-air hoods are often used to dry barrier coatings in order to slowly heat the coating and prevent premature film formation. The disadvantage is the size of the machines and the low production speed. Most manufacturers of barrier papers have already found that gas-powered infrared emitters are counterproductive. Electrically operated infrared emitters are the tool of choice, but here too there are different concepts with distinct energy efficiency.

Compact Engineering has developed special infrared lamps which allow coatings to be dried starting with the initial sedimentation layer and which are particularly energy efficient. With barrier coatings, high production speeds can be achieved without compromising on paper quality. The cost efficiency is similar to the efficiency of gas-powered infrared emitters.

This article examines the physical principles of drying coatings, but in particular those of functional coatings, which are typical for barrier papers. At the same time, it is shown how dryers specifically developed on the basis of these physical laws extend the narrow operating window for papermakers in the production of barrier papers.

In addition, an application case for drying a special coating based on a polyvinyl alcohol is presented.

2. Difficulties in Barrier Drying

Barrier coatings are particularly difficult to dry, and papermakers often complain about the small operating windows of their coaters. In addition to the difficulties of normal coat drying, there is the problem that the drying of the coating activates the barrier. If the surface dries too quickly, it films prematurely and further water cannot be evaporated through the barrier. However, the water under the film will later - or usually earlier - make its way to the surface and escape through the barrier. The result is micro blistering.

For this reason, drying with hot air hoods has become the established method nowadays, in which the surface temperature is increased very slowly by means of low production speeds and long dryers. Thus the temperature in the coating can slowly equalise itself. This prevents premature filming at the expense of low production capacity.

It has already been discussed among manufacturers of barrier papers that gas-powered infrared dryers installed in front of the hot-air hoods should not be used in coating machines in order not to endanger the quality of the barrier. However, most users are unaware of the physical principles involved.

3. Physical Principles of Drying

Drying is a two-step process. In the first step energy is transferred to the material to be dried, in the second step the evaporated solvent is removed. In paper making and coating, water is used as the solvent. Ideally, when the water evaporates, most of the energy is removed from the material to be dried - paper or coating.

The energy transfer can take place in different ways:

- Heat Conduction: in papermaking, this is done by steam-heated drying cylinders whose hot surface heats the material to be dried in direct contact. This is the most effective way of transferring energy, but can only be used for coatings once they have reached their immobilisation dry solids.
- Radiation: this is done either by infrared or microwave, the latter being difficult to use on an industrial scale. Radiation is normally the most expensive form of energy transmission, but in special applications it is the most energy-efficient.
- Convection: by means of a transmitter such as air, water, or oil. The latter two are not suitable for drying. In paper industry, typically hot air is used. Hot air drying is the most cost-effective way of transferring energy, but less efficient than heat conduction.

3.1. Coat Drying by Means of Hot Air

Hot-air hoods are used after the coating head, which blow dry, warm air onto the surface of the material to be dried and simultaneously exhaust the moist air again. The main disadvantage of hot air drying is that it only heats the surface of the material to be dried. Therefore, during coat drying, care must be taken to ensure that the temperature rises slowly enough in the passage under the drying hoods to control migration into the substrate and avoid mottling. If the surface is heated too quickly, the liquid phase of the coating flows too quickly into the substrate. This is especially a problem as the basis weight increases.

With barrier drying, the temperature increase must be slower than with normal coat drying. Heating of the surface must be slower than heat conduction within the coating. Otherwise, the coating surface heats up too quickly, which leads to a depletion of water on the surface. On the other hand, the film formation temperature of the barrier chemicals is reached. Both together lead to a film formation of the barrier at the surface and thus to a dramatic reduction of the water permeability - which in many cases is the purpose of the barrier. The water trapped under the barrier will later make its way to the surface in the course of further drying and thus lead to micro blistering.

3.2. Coat Drying by Radiation

In coat drying, infrared radiators are therefore frequently used in front of the hot-air hoods in order to immobilize the coating more quickly and to introduce energy below the surface into the dry material. Both, gas-operated as well as electrically operated infrared emitters are in use.